PhytoKeys 126: 127–138 (2019)
doi: 10.3897/phytokeys.126.35442
http://phytokeys.pensoft.net

RESEARCH ARTICLE

A peer-reviewed open-access journal
PhytoKeys
Launched to accelerate biodiversity research

Persicaria jucunda var. *rotunda* (Polygonaceae, Persicarieae), a distinct distylous taxa raised to specific rank

Yue-Ning Guo[1], Shao-Feng Chen[1], Ming-Lin Chen[2], Bo Li[3]

1 *School of Life Sciences, Nanchang University, Nanchang 330031, Jiangxi, China* **2** *Provincial Key Laboratory of Biotic Environment and Ecological Safety in Anhui, Anhui Normal University, Wuhu 241000, Anhui, China* **3** *Research Centre of Ecological Sciences, Jiangxi Agricultural University, Nanchang 330045, Jiangxi, China*

Corresponding author: *Bo Li* (hanbolijx@163.com)

Academic editor: *Alexander Sukhorukov* | Received 14 April 2019 | Accepted 13 June 2019 | Published 16 July 2019

Citation: Guo Y-N, Chen S-F, Chen M-L, Li B (2019) *Persicaria jucunda* var. *rotunda* (Polygonaceae, Persicarieae), a distinct distylous taxa raised to specific rank. PhytoKeys 126: 127–138. https://doi.org/10.3897/phytokeys.126.35442

Abstract

Persicaria jucunda (Meisn.) Migo var. *rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li was originally published in the genus *Polygonum* L. and treated as a variety of *P. rotundum* Meisn. [≡*Persicaria jucunda* (Meisn.) Migo]. After carefully comparing the macro- and micro-morphological characteristics of the achenes, leaf epidermis and tepals and the habitat between the variety and its typical variety, we confirmed that *P. jucunda* var. *rotunda* is clearly different from *P. jucunda* and should not be treated as a variety, but be raised to a specific rank as *P. rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li. The species is distylous and could be easily distinguished from all other *Persicaria* taxa by a combination of morphological characters, such as completely decumbent leafless basal branches, almost sessile leaves, linear-lanceolate with rounded leaf bases, spicate, short and dense inflorescences, slender pedicels longer than bracts and dimorphic flowers and achenes. *P. rotunda* is endemic to several large wetlands of eastern China and usually occurs as one of the dominant species in some plant communities.

Keywords

Distyly, micro-morphology, new combination, *Polygonum,* variety

Introduction

Persicaria (L.) Mill., after separation from the former polyphyletic genus *Polygonum* L., is currently placed within the tribe Persicarieae of Polygonaceae. The genus contains approximately 150 species of annual or perennial herbs and occurs mainly

Copyright *Yue-Ning Guo et al.* This is an open access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

in temperate and subtropical regions of the Northern Hemisphere (Brandbyge 1993). *Persicaria* is characterised by having usually entire, ciliate or pectinate ocrea, many-flowered, spike-like or capitate inflorescences, 4–5-lobed tepals with trifid venation, 4–8 stamens, spheroidal pollen grains with reticulate exine and epidermis of pericarp with narrow rectangular cells and undulating anticlinal walls (Haraldson 1978, Ronse Decraene and Akeroyd 1988, Brandbyge 1993, Ronse Decraene et al. 2000). The genus has been subdivided into four sections on the basis of anatomical traits (Haraldson 1978), viz., sect. *Persicaria*, sect. *Cephalophilon* (Meisn.) H.Gross, sect. *Echinocaulon* (Meisn.) H.Gross and sect. *Tovara* (Adans) H.Gross, while Galasso et al. (2009) proposed to include another two sections, sect. *Amphibia* Tzvelev and sect. *Truelloides* Tzvelev, based on molecular phylogenetic studies. In *Persicaria*, a number of species have been observed or confirmed as distylous, such as *P. chinensis* (L.) H.Gross (≡*Polygonum chinense* L.) (Reddy et al. 1977), *P. japonica* (Meisn.) H.Gross (Hiratsuka and Nakao 1996), *P. jucunda* (Meisn.) Migo (≡*Polygonum rotundum* Meisn.) (Chen and Zhang 2010), *P. hastato-sagittatua* (Mak.) Nakai ex Mori (≡*Polygonum hastato-sagittatum* Mak.) (Chen 2012), *P. wugongshanensis* Bo Li (Li 2014) and *P. odorata* (Lour.) Soják subsp. *conspicua* (Nakai) Yonek. (Kong and Hong 2018). Distyly is a type of heterostyly which is characterised by the reciprocal placement of stigmas and anthers in two (distyly) or three (tristyly) floral morphs in a species (Lloyd and Webb 1992).

Persicaria jucunda var. *rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li (Li et al. 2013) was originally published in the genus *Polygonum* and treated as a variety of *P. rotundum* (≡*Persicaria jucunda*) (Zhou et al. 2007). The variety resembles *P. rotundum* in having glabrous stems and prostrate at base, densely spicate inflorescences, pinkish tepals, slender pedicels longer than bracts and trigonous achenes, but differs from the typical variety in having truncate and linear-lanceolate leaf blades with barely noticeable petioles (Zhou et al. 2007). However, when conducting a micro-morphological study of Chinese *Persicaria* species, we found that there are a number of distinct differences between the two taxa, including the shape of epidermal cells of both leaf sides, the occurrence of stomata on adaxial leaf surface, the stomatal type of abaxial leaf surface and the sculpture of achene surface. After re-examining the macro-morphology and the habitat of the two taxa, we confirmed that *P. jucunda* var. *rotunda* is clearly different from *P. jucunda* and should not be treated as a variety, but be raised to a specific rank as *Persicaria rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li.

Materials and Methods

The field investigations were carried out from 2014 to 2019. Fresh leaf materials and flowers of both *P. jucunda* and *P. rotunda* were collected and immediately fixed in FAA solution (formalin: acetic acid: alcohol = 18:1:1). The measurement of morphological characters was conducted based on both herbarium specimens (JXAU, acronym according to Thiers 2019) and living plants by using a micrometer and a stereomicroscope. To make a morphological comparison between *P. jucunda* and *P. rotunda*, the variability

of four quantitative characters (leaf length, leaf width, number of leaf lateral vein pairs, inflorescence length) was evaluated using univariate statistics (box plots) by SPSS 11.5 statistical software package (SPSS Inc., Chicago, IL, USA). To confirm the distyly in *P. rotunda*, the height of stigmas and anthers were measured for a single flower removed from 30 individuals per style morph. Methodology follows Chen and Zhang (2010).

For light microscopy (LM) observation of leaf epidermis, samples were taken from the mature leaves fixed in FAA solution, dissected under a OPTPro stereoscope (Chongqing Optec Instrument Co. Ltd., China), stained in a solution of 1% safranin, and cleaned in distilled water three times before being mounted in glycerine jelly. Observations and micrographs were conducted randomly from 5 prepared slides per species under LM. Terminology follows Hou (2006).

For scanning electron microscopy (SEM) observations, samples of achenes were removed from mature fruits and dried in silica gel. After cleaned in 95% ethanol, mounted on to cupreous stubs and coated by JFC-1100E sputter coater (JEOL Led., Japan), samples were examined under JSM-6360LV SEM (JEOL Led., Japan) at a voltage of 25 KV. Terminology follows Ronse Decraene et al. (2000).

Taxonomy

***Persicaria rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li, comb. & stat. nov.**

urn:lsid:ipni.org:names:77199242-1

Figures 1, 2

≡*Polygonum jucundum* Meisn. var. *rotundum* Z.Z.Zhou & Q.Y.Sun, Acta Phytotax. Sin. 45(5): 714 (713–718; figs.). 2007. **Type:** CHINA. Anhui Province, Dongzhi County, Shengjin Lake, on riparian plains, Alt. 6–20 m, 4 October 2006, *Z.Z.Zhou 0602* (holotype: PE!, isotype: ANU).

≡*Persicaria jucunda* (Meisn.) Migo var. *rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li, Phytotaxa 91 (1): 24. 2013.

Diagnosis. This species is easily distinguished from other *Persicaria* taxa by its completely decumbent leafless basal branches, almost sessile leaves, truncate, linear-lanceolate leaf blades, spicate, short and dense inflorescences, pedicels longer than bracts and dimorphic flowers and achenes. It occurs as one of the dominant species of some lakeshore plant communities in several large wetlands of northern Jiangxi and southwestern Anhui provinces, eastern China.

Description. *Annual herbs. Stems* slender, glabrous, basal branches 6–26, completely decumbent, 3–15 cm long, leafless, dark brown, producing numerous fibrous roots at each node; 3–12 additional flowering shoots branched from the upper nodes of each basal branch, 6–65 cm high, prostrate to erect, green to purplish-red, nodes inflated, purple. *Leaves* nearly sessile; leaf blades narrowly lanceolate to linear-lanceolate, 1.5–12.5 cm long, 0.3–1.3 cm wide, lateral veins 9–16 pairs, both surfaces glabrous,

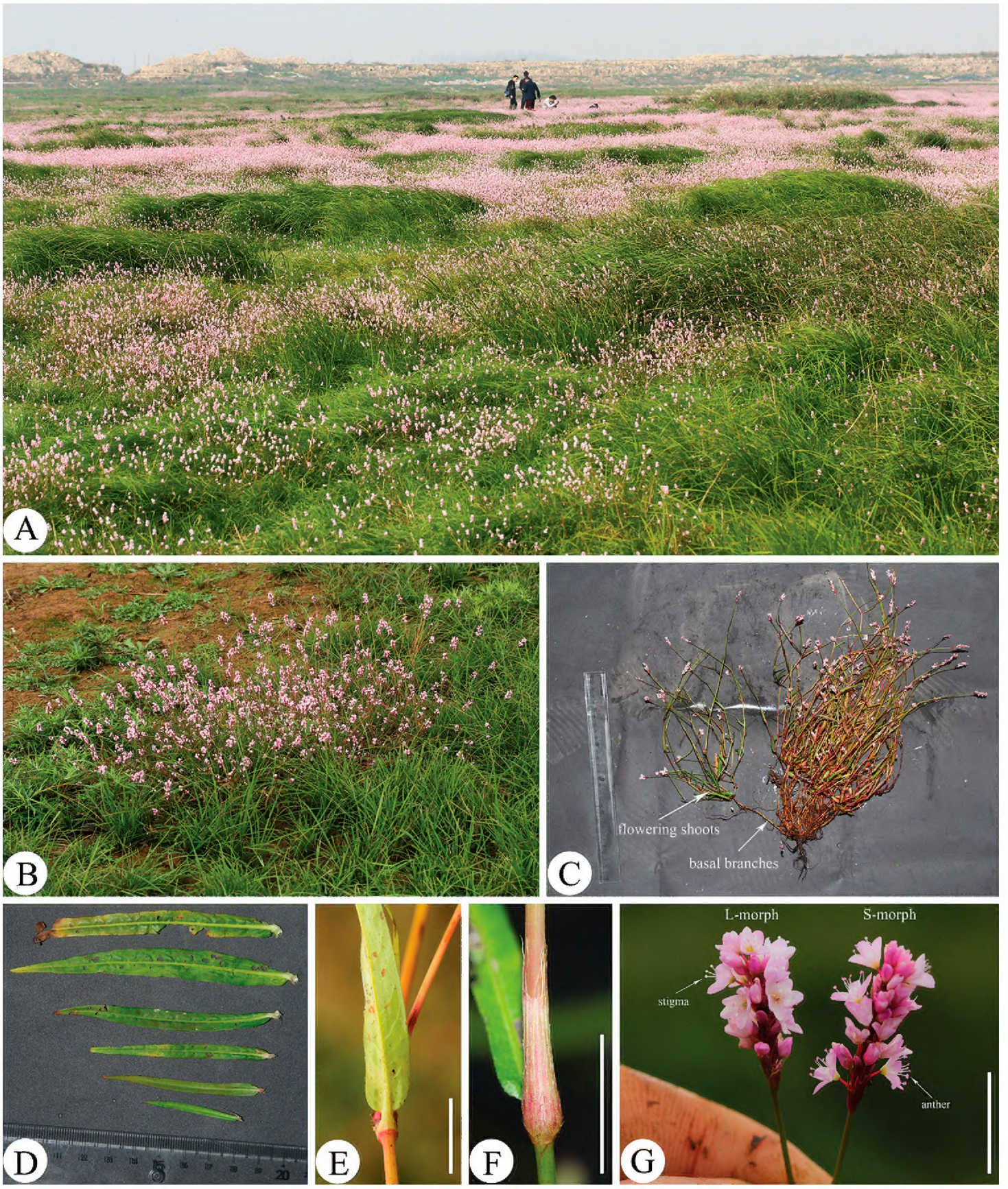

Figure 1. *Persicaria rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li **A** plant community with *P. rotunda* **B** close-up view of an individual in situ **C** an individual showing branches **D** leaves **E** leaf base **F** ocrea **G** inflorescences. Scale bars: 1 cm (**E, F, G**).

base round, apex acuminate, margin entire, shortly ciliate. *Ocrea* tubular, 4.5–11.5 mm long, membranous, sparsely appressed pubescent, apex truncate, fimbriate, cilia 2.2–5.3 mm long. *Inflorescence* terminal, erect, spicate, dense, 0.5–3.8 cm long; peduncle 3.5–6.5 cm long, glabrous; bracts purplish-red, funnel-shaped, sparsely pubescent, margin submembranous, shortly ciliate, each bract contains 4–7-flowers. *Pedicel* longer than bracts, 1.5–2.5 mm. *Flowers* dimorphic; perianth 5-parted, pinkish-white;

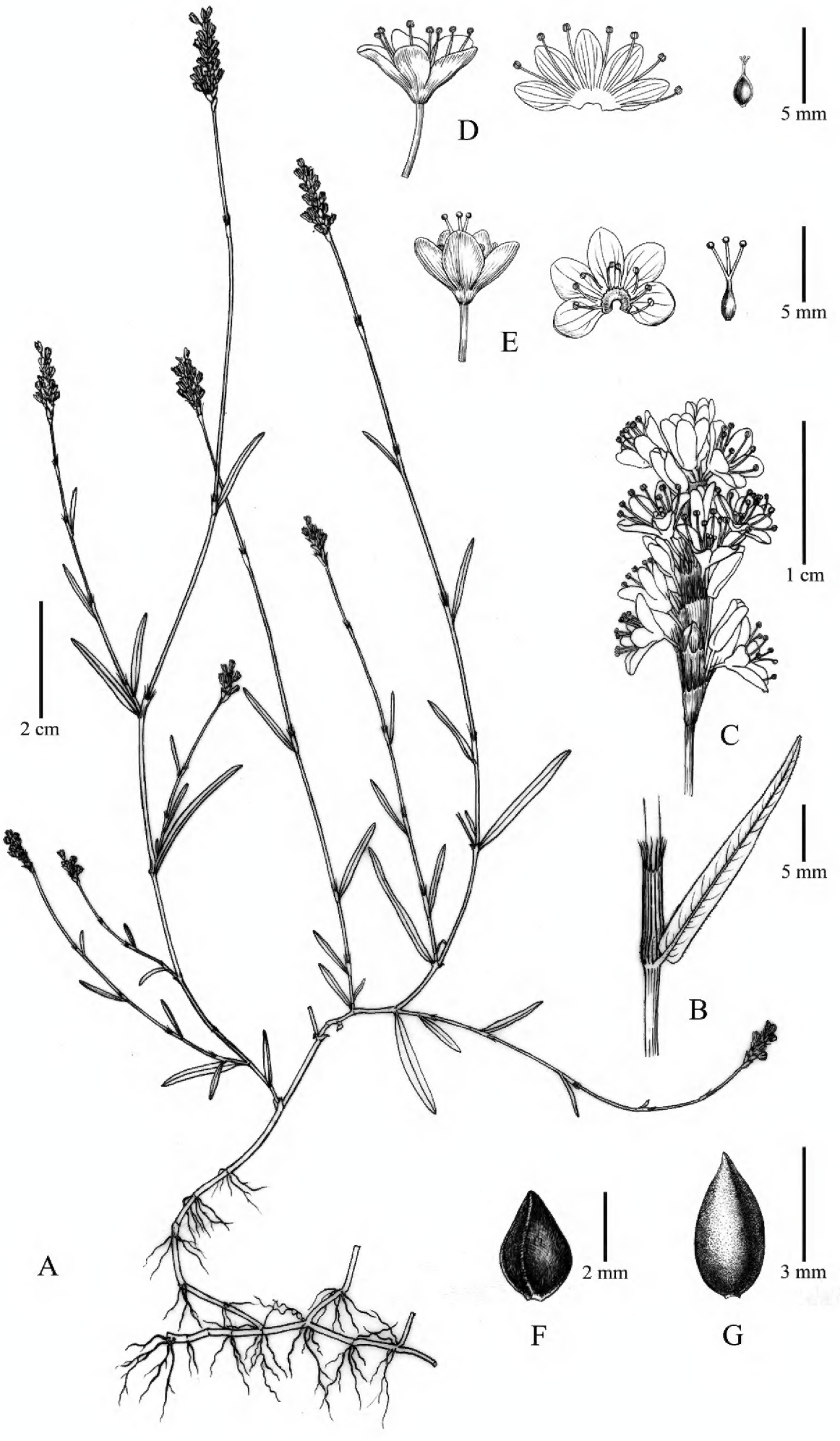

Figure 2. Line drawing of *Persicaria rotunda* (Z.Z.Zhou & Q.Y.Sun) Bo Li **A** branches and inflorescences **B** ocrea and leaf **C** inflorescence **D** S-morph flower and its pistil **E** L-morph flower and its pistil **F** S-morph achene **G** L-morph achene.

long-styled flowers (called as L-morph) 3.9–4.4 mm long, stamens 8, 2.6–3.2 mm, styles 3, connate to below middle, 4.3–5.1 mm, exserted; short-styled flowers (called as S-morph) 3.7–4.2 mm long, stamens 8, 3.8–4.9 mm, exserted, styles 3, connate to below middle, 2.4–2.9 mm; stigmas capitate; nectaries 8, arranged at the base of ovary. *Achenes* included in persistent perianth, dimorphic; L-morph dark brown, ellipsoid, trigonous, base rounded to broadly cuneate, apex acuminate, surface opaque, densely reticular - pitted, 3.6–4.2 mm long, 2.1–2.3 mm wide; S-morph black, ovoid, trigonous, base broadly cuneate, apex acute, surface opaque, densely pitted, 2.9–3.3 mm long, 1.8–2.1 mm wide.

Phenology. Flowering was observed from July to December and fruiting from late July to January.

Distribution and habitat. *Persicaira rotunda* is currently known only from several wetlands in north of Jiangxi Province and southwest of Anhui Province, eastern China and mainly grows in marshy and grassy areas around Daguan Lake, Lihu Lake, Longgan Lake, Poyang Lake Qingcao Lake, Shengjin Lake, Shimeng Lake and Wuchang Lake, which are several small to large lakes located near the Yangtze River. It usually occurs as one of the dominant species of some lakeshore plant communities (Fig. 1A).

Specimen examined. CHINA. Jiangxi Province, Xingzi County, Shenling Lake, on grassy lakeside, Alt. 10 m, 29.270044N, 116.040173E, 16 July 2008, *B.Li JX046* (IBSC); Jiangxi Province, Yongxiu County, Wucheng Town, Poyang Lake, in wet meadow, Alt. 14 m, 29.114364N, 116.032021E, 11 December 2017, *B.Li LB0778* (JXAU); Jiangxi Province, Yongxiu County, Wucheng Town, Poyang Lake, in wetland marsh, Alt. 6 m, 29.133935N, 116.053571E, 15 October 2018, *B.Li LB0901* (JXAU).

Notes. As noted by Zhou et al. (2007), *P. rotunda* is most similar to *P. jucunda* (Fig. 3) in gross morphology, particularly in having uninterrupted spicate inflorescences with dense flowers and slender pedicels longer than bracts. However, the authors did not notice that both of the species are distylous, which is another important similarity between the two taxa. The distyly of *P. jucunda* was firstly observed and confirmed by Chen and Zhang (2010). In the present study, we confirmed that *P. rotunda* is also a typical distylous species. The heights of the stigmas (4.63 ± 0.191 mm vs. 2.61 ± 0.056 mm, L-morph vs. S-morph) and anthers (2.74 ± 0.092 mm vs. 4.68 ± 0.178 mm, L-morph vs. S-morph) are reciprocal in the two morphs. However, *P. rotunda* is clearly different from *P. jucunda,* not only in some morphological traits (Fig. 4), but also in several micro-morphological characters (Table 1).

Besides the differences summarised by Zhou et al. (2007), such as leaf shape, leaf width, petiole length and stem diameter, we observed several additional morphological traits that are clearly distinct between *P. rotunda* and *P. jucunda*. The stems of *P. rotunda* have 6–26 basal branches which are leafless and completely decumbent with numerous fibrous roots at each node. On the upper nodes of each basal branch, there are 3–12 flowering shoots which are prostrate to erect and normally bearing leaves and inflorescences (Fig. 1C). However, the stems of *P. jucunda* are mostly erect or only prostrate at the base and the number of its branches are much fewer than those of *P. rotunda*. *Persicaria rotunda* also has more pairs of leaf lateral veins and much shorter inflorescences than *P. jucunda* (Fig. 4).

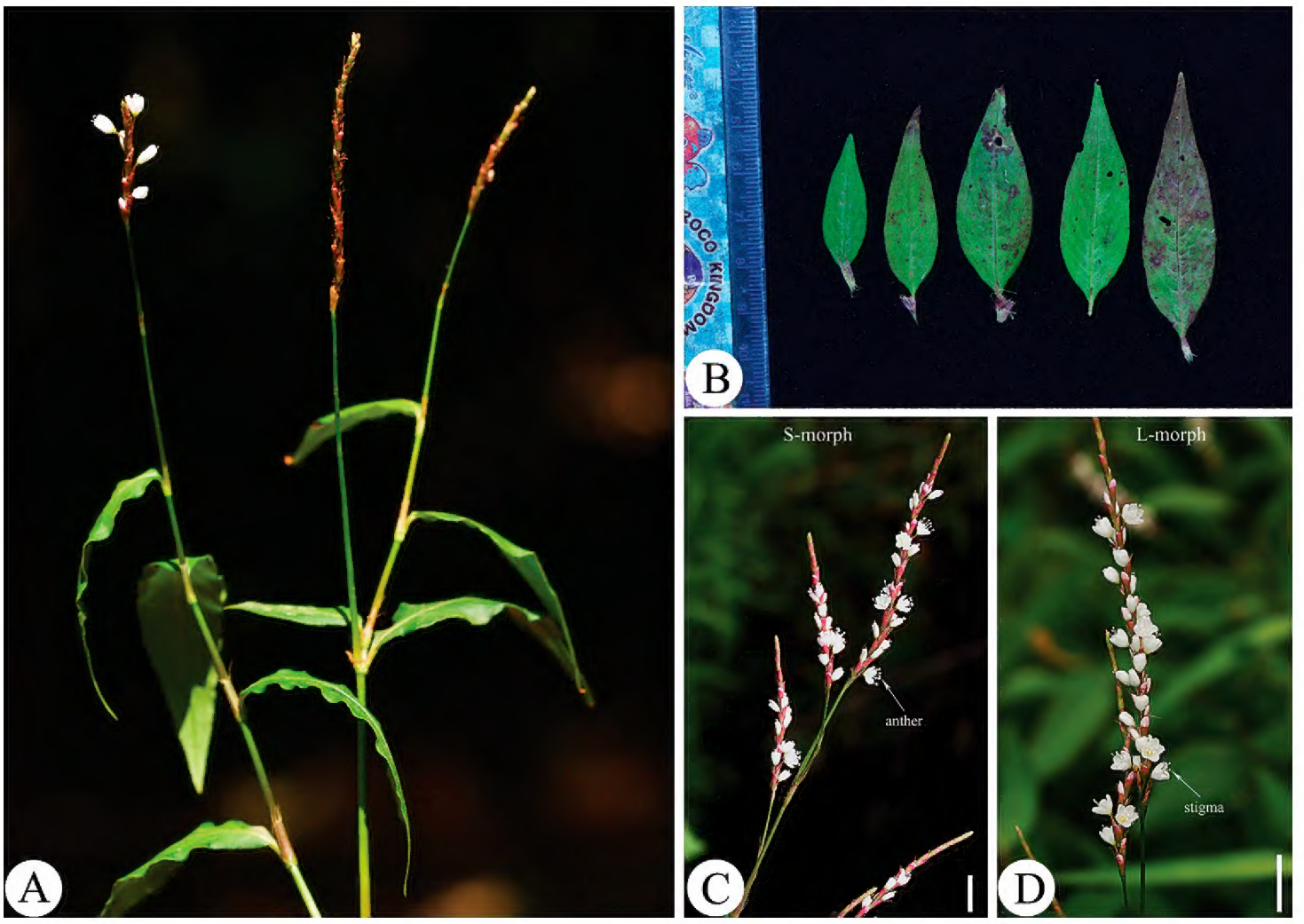

Figure 3. *Persicaria jucunda* (Meisn.) Migo **A** habit **B** leaves **C** S-morph inflorescences **D** L-morph inflorescences. Scale bars: 1 cm (**C, D**).

Table 1. Differences between *Persicaria rotunda* and *P. jucunda*.

		Persicaria rotunda	*P. jucunda*
Habitat		wetlands	forest margins, grassy slopes or moist valleys
Branches		the primary branches completely decumbent, leafless and the secondary branches prostrate to erect	ascending to erect, without leafless branches
Leaves	Petiole	nearly absent	3–6 mm long
	Shape	narrowly lanceolate to linear-lanceolate	lanceolate or elliptic-lanceolate
	Lateral veins (pairs)	9–16	6–10
	Adaxial epidermis	polygonal epidermal cells with straight anticlinal walls no stomata no glands	irregular epidermal cells with straight to curved anticlinal walls stomata mostly anisocytic or occasionally paracytic sparse two-celled peltate glands
	Abaxial epidermis	irregular epidermal cells with curved to sinuolate anticlinal walls stomata anisocytic plenty of four-celled peltate and spheroidal glands	irregular epidermal cells with sinuolate to sinuate anticlinal walls stomata paracytic no glands
Length of Inflorescences (cm)		0.5–3.8	1.0–8.2
Tepals	Length (mm)	L-morph 3.9–4.4, S-morph 3.7–4.2	L-morph 2.8–3.3, S-morph: 2.7–3.2
	Epidermis	anticlinal walls of epidermal cells curved to sinuolate 10–14 sinuate striates on cuticular layer	anticlinal walls of epidermal cells sinuolate to sinuate 12–18 straight to sinuolate striates on cuticular layer
Achenes	Size (length × width, mm)	L-morph 3.6–4.2 × 2.1–2.3, S-morph 2.9–3.3 × 1.8–2.1	L-morph 2.1–2.6 × 1.6–1.8, S-morph 2.2–2.7 × 1.7–1.9
	Surface	opaque, densely pitted	shiny, smooth
	Epidermal ornamentations	reticulate	Indistinctly reticulate

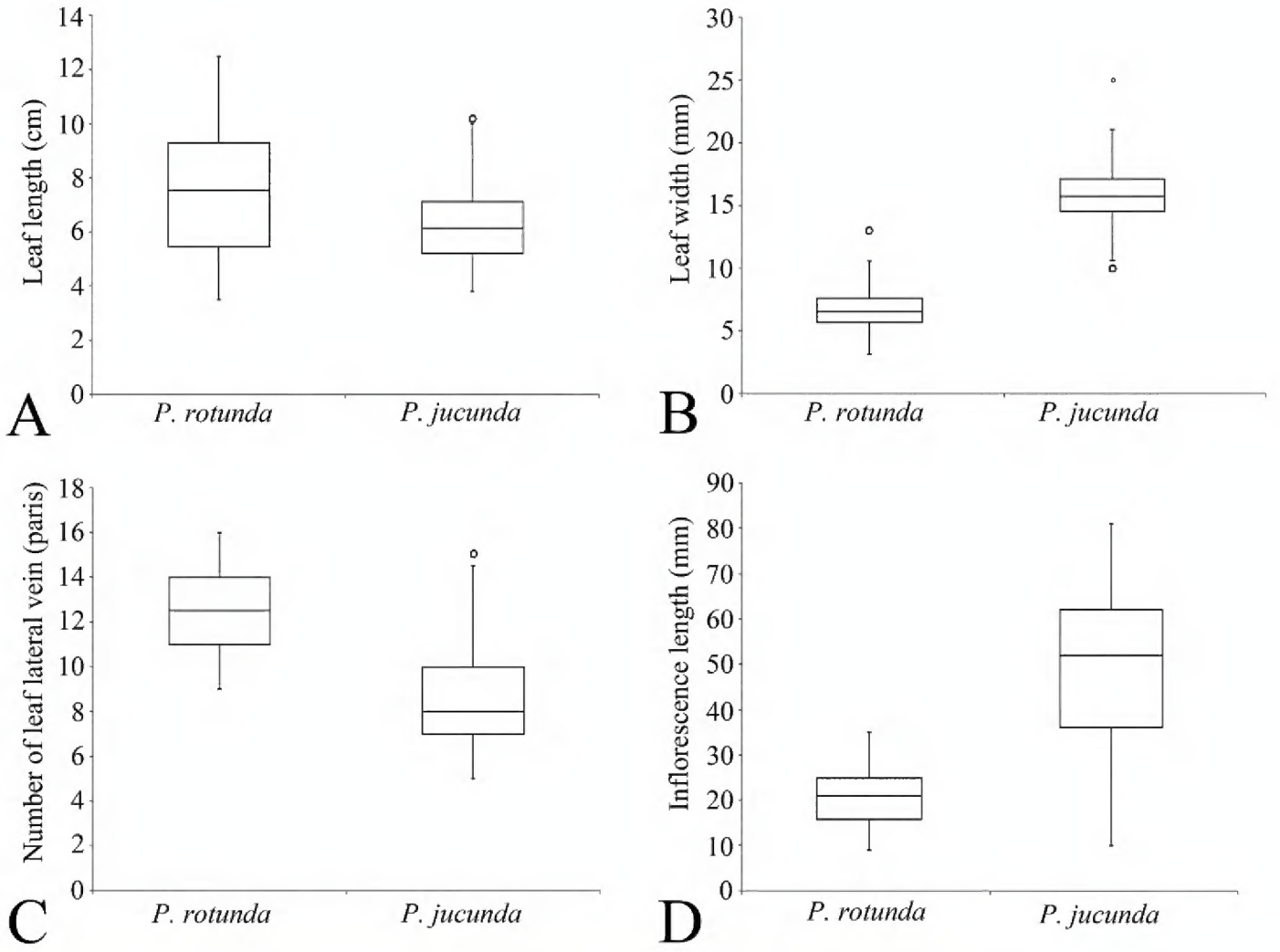

Figure 4. Box plots of four quantitative characters, leaf length (**A**) leaf width (**B**) number of leaf lateral vein pairs (**C**) and inflorescence length (**D**) of *Persicaria rotunda* and *P. jucunda*. The boxes (rectangle region) represent the interquartile range and the whiskers (vertical line) represent the range excluding the outliers (circles). The three upper, middle and lower lines on the boxes represent the 75%, 50% and 25% of the variables, respectively. The upper and lower ends of the whiskers represent the maximum and minimum values of the variable, respectively. The circles represent the single value, where the variable value exceeds 1.5 times the difference between the 75% and 25%.

Though both of *P. rotunda* and *P. jucunda* have dimorphic flowers, the achenes of *P. rotunda* are also dimorphic, with the L-morph ellipsoid in shape and dark brown in colour, whereas the S-morph achene is ovoid in shape and black in colour (Fig. 5A). Additionally, the L-morph achenes of *P. rotunda* have larger size and more raised reticulate epidermal ornamentations than those of the S-morph (Figs. 5B–E). In contrast, the achenes of *P. jucunda* are homomorphic with the same smooth surfaces in both morphs (Chen and Zhang 2010). Amongst the distylous taxa reported in *Persicaria*, *P. rotunda* is, so far, the only species that shows dimorphic features on achenes.

Leaf epidermis characters have been tested to be of important taxonomic significance in *Persicaria* (Hou 2006, Zhu et al. 2007, Yasmin et al. 2010). When observing the leaf epidermis of *P. rotunda* and *P. jucunda*, we found that there are significant differences in the leaf epidermal micro-morphology of the two taxa (Fig. 6). In *P. rotunda*, the adaxial leaf epidermal cells are polygonal in shape with the straight anticlinal walls and no stomatal apparatus or gland occurs on the surface (Fig. 6A). However, the adaxial leaf epidermis of *P. jucunda* is covered by irregular epidermal

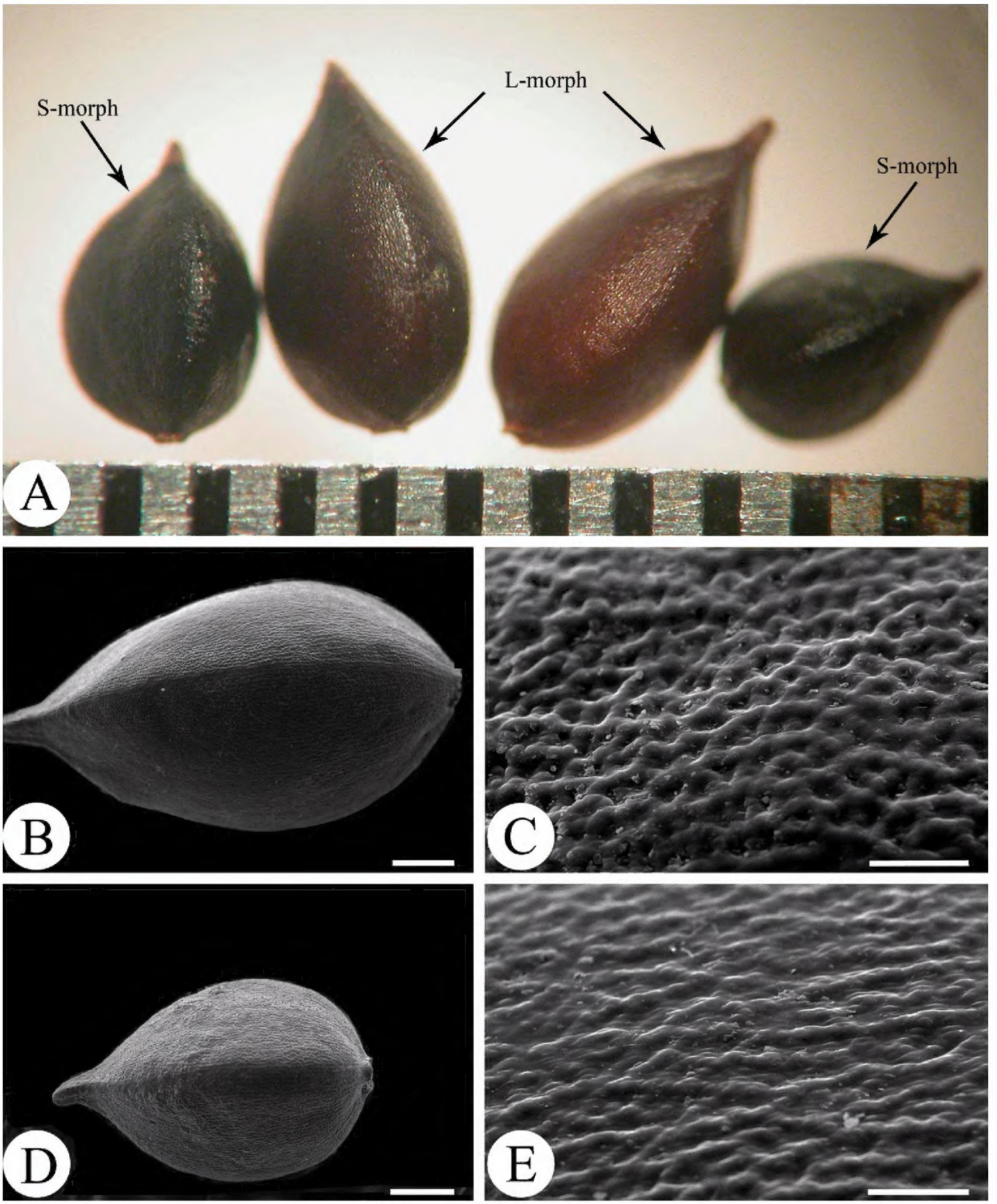

Figure 5. Achene morphology of *Persicaria rotunda* **A** dimorphic achenes under a stereoscope **B–C** SEM micrograph of L-morph achene **B** whole view **C** partial view showing its epidermis sculpture **D–E** SEM micrograph of S-morph achene **D** whole view **E** partial view showing its epidermis sculpture. Scale bars: 500 μm (**B, D**); 50 μm (**C, E**).

cells with the anticlinal walls straight to curved and has mostly anisocytic or occasionally paracytic stomata and sparsely two-celled peltate glands (Fig. 6C). On the abaxial leaf epidermis, plenty of four-celled peltate and spheroidal glands, anisocytic stomata and irregular epidermal cells with the anticlinal walls curved to sinuolate were observed for *P. rotunda* (Fig. 6B), while in *P. jucunda*, no glands have been

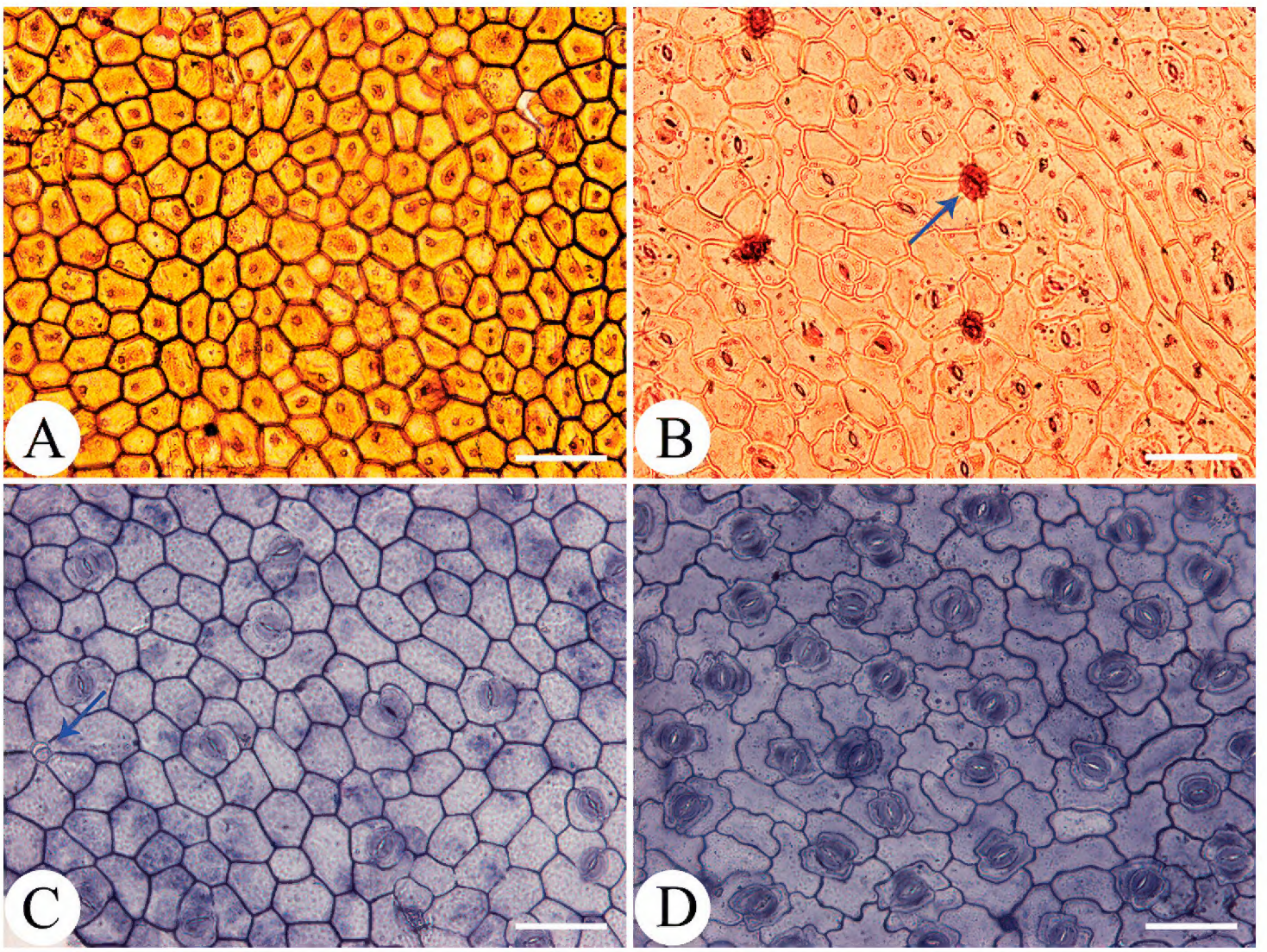

Figure 6. LM micrographs of leaf epidermis of *Persicaria rotunda* (**A, B**) and *P. jucunda* (**C, D**). **A, C** upper epidermis **B, D** lower epidermis. Arrow in B shows the four-celled peltate and spheroidal glands of *P. rotunda* and in **C** indicates the two-celled peltate glands of *P. jucunda*. Scale bars: 500 μm.

found, the stomata are paracytic and the anticlinal walls of epidermal cells are sinuolate to sinuate (Fig. 6D).

In the protologue, Zhou et al. (2007) also investigated the tepal micro-characteristics of *P. rotunda* and *P. jucunda* and listed their differences: the anticlinal walls of epidermal cells are curved to sinuolate in *P. rotunda*, while sinuolate to sinuate in *P. jucunda*; the cuticular layer has longitudinally 10–14 of sinuate striates in *P. rotunda*, while 12–18 straight to sinuolate striates in *P. jucunda*. Taking all the above morphological and micro-morphological evidence together, we think that *P. rotunda* represents a distinct species in *Persicaria* and it should not be placed under *P. jucunda* as a variety, but be treated as a separate species.

Acknowledgements

The authors are grateful to Ms. Yun-Xiao Liu for the line-drawing illustrations, to Ms. Xiao-Ying Hu for technical assistance with SEM observation and to Dr. Xin-Xin Zhu for providing some photos of *Persicaria jucunda*. This work was supported by the National Natural Science Foundation of China (grant no. 31660047) and Natural Science Foundation of Anhui Province (grant no. 1808085MC76).

References

Brandbyge J (1993) Polygonaceae. In: Kubitzki K, Bittich V (Eds) The Families and Genera of Vascular Plants, Vol. 2. Flowering plants. Dicotyledons: Magnoliid, Hamamelid and Caryophyllid Families. Springer Verlag, Berlin, 531–544. https://doi.org/10.1007/978-3-662-02899-5_63

Chen ML (2012) Floral morphology and breeding system in *Polygonum hastato-sagittatum* Mak. (Polygonaceae). Flora 207(5): 365–371. https://doi.org/10.1016/j.flora.2012.01.012

Chen ML, Zhang XP (2010) Distyly in *Polygonum jucundum* Meisn. (Polygonaceae). Plant Systematics and Evolution 288(3–4): 139–148. https://doi.org/10.1007/s00606-010-0318-x

Galasso G, Banfi E, Mattia FD, Grassi F, Sgorbati S, Labra M (2009) Molecular phylogeny of *Polygonum* L. s.l. (Polygonoideae, Polygonaceae), focusing on European taxa: Preliminary results and systematic considerations based on *rbcL* plastidial sequence data. Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturale di Milano 150: 113–148. https://doi.org/10.1007/s00606-010-0318-x

Haraldson K (1978) Anatomy and taxonomy in Polygonaceae subfamily Polygonoideae Meisn. emend. Jaretzky. Symbolae Botanicae Upsalienses 22: 1–95.

Hiratsuka A, Nakao R (1996) *Persicaria japonica* (Meisn.) H. Gross, a heterostylous species in the Polygonaceae. Shokubutsu Kenkyu Zasshi 71: 98–104.

Hou YT (2006) Systematic studies on the tribe Polygoneae of China. Shandong Normal University, Jinan.

Kong MJ, Hong SP (2018) Morphological traits of a distylous taxon, *Persicaria odorata* subsp. *conspicua* (Polygonaceae). Flora 243: 58–66. https://doi.org/10.1016/j.flora.2018.03.010

Li B (2014) *Persicaria wugongshanensis* (Polygonaceae: Persicarieae), an odoriferous and distylous new species from Jiangxi, eastern China. Phytotaxa 156(3): 133–144. https://doi.org/10.11646/phytotaxa.156.3.4

Li B, Fan DM, Lei SQ, Zhang ZY (2013) New combinations in *Persicaria* (Polygonaceae: Persicarieae) for the Flora of China. Phytotaxa 91(1): 24–26. https://doi.org/10.11646/phytotaxa.91.1.2

Lloyd DG, Webb CJ (1992) The evolution of heterostyly. In: Barrett SCH (Ed.) Evolution and function of heterostyly. Springer, Berlin, 151–178. https://doi.org/10.1007/978-3-642-86656-2_6

Reddy NP, Bahadur B, Kumar PV (1977) Heterostyly in *Polygonum chinense* L. Journal of Genetics 63(2): 79–82. https://doi.org/10.1007/BF02984278

Ronse Decraene LP, Akeroyd JR (1988) Generic limits in *Polygonum* and related genera (Polygonaceae) on the basis of floral characters. Botanical Journal of the Linnean Society 98(4): 321–371. https://doi.org/10.1111/j.1095-8339.1988.tb01706.x

Ronse Decraene LP, Hong SP, Smets E (2000) Systematic significance of fruit morphology and anatomy in tribes Persicarieae and Polygoneae (Polygonaceae). Botanical Journal of the Linnean Society 134(1–2): 301–337. https://doi.org/10.1111/j.1095-8339.2000.tb02356.x

Thiers B (2019) Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/ [accessed 15 January 2019]

Yasmin G, Khan MA, Shaheen N, Hayat MQ (2010) Taxonomic significance of leaf epidermal anatomy of selected *Persicaria* Mill. species of family Polygonaceae from Pakistan. African Journal of Biotechnology 9: 3759–3768.

Zhou ZZ, Sun Q, Xu W, Shen J, Xu L, Zhao X (2007) *Polygonum jucundum* var. *rotundum* Z.Z. Zhou & Q.Y. Sun, a new variety of Polygonaceae from Anhui, China. Zhiwu Fenlei Xuebao 45(05): 713–718. https://doi.org/10.1360/aps06205

Zhu LT, Lu FJ, Hou YT, Li FZ (2007) Micro-morphology of leaf epidermis and its taxonomical significance of *Polygonum* section *Cephalophilon.* Journal of Wuhan Botanical Research 25: 136–142.